U.S. FISH AND WILDLIFE SERVICE
SPECIES ASSESSMENT AND LISTING PRIORITY ASSIGNMENT FORM

SCIENTIFIC NAME: *Pyrgulopsis morrisoni*

COMMON NAME: Page springsnail

LEAD REGION: 2

INFORMATION CURRENT AS OF: April 2010

STATUS/ACTION

___ Species assessment - determined we do not have sufficient information on file to support a proposal to list the species and, therefore, it was not elevated to Candidate status
___ New candidate
_X_ Continuing candidate
___ Non-petitioned
_X_ Petitioned - Date petition received: April 11, 2002
_ 90-day positive - FR date:
_ 12-month warranted but precluded - FR date:
_ Did the petition request a reclassification of a listed species?

FOR PETITIONED CANDIDATE SPECIES:
a. Is listing warranted (if yes, see summary of threats below)? yes
b. To date, has publication of a proposal to list been precluded by other higher priority listing actions? yes
c. If the answer to a. and b. is "yes", provide an explanation of why the action is precluded.
Higher priority listing actions, including court-approved settlements, court-ordered statutory deadlines for petition findings and listing determinations, emergency listing determinations, and responses to litigation, continue to preclude the proposed and final listing rules for the species. We continue to monitor populations and will change its status or implement an emergency listing if necessary. The "Progress on Revising the Lists" section of the current CNOR (*http://endangered.fws.gov/*) provides information on listing actions taken during the last 12 months.

_X__ Listing priority change
Former LP: _2__
New LP: _8__

Date when the species first became a Candidate (as currently defined): February 28, 1996
___ Candidate removal: Former LPN: ___
___ A – Taxon is more abundant or widespread than previously believed or not subject to

the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status.

___U – Taxon not subject to the degree of threats sufficient to warrant issuance of a proposed listing or continuance of candidate status due, in part or totally, to conservation efforts that remove or reduce the threats to the species.

___ F – Range is no longer a U.S. territory.

___ I – Insufficient information exists on biological vulnerability and threats to support listing.

___ M – Taxon mistakenly included in past notice of review.

___ N – Taxon does not meet the Act's definition of "species."

___ X – Taxon believed to be extinct.

ANIMAL/PLANT GROUP AND FAMILY: Snails: Gastropoda, Hydrobiidae

HISTORICAL STATES/TERRITORIES/COUNTRIES OF OCCURRENCE: Arizona

CURRENT STATES/COUNTIES/TERRITORIES/COUNTRIES OF OCCURRENCE: Yavapai County, Arizona

LAND OWNERSHIP: Bubbling Springs, Bass House Springs, remnants of Page Springs (Cave Springs and Ash Tree Springs), and other unnamed springs are located on property owned by the Arizona Game and Fish Commission and managed by the Arizona Game and Fish Department (AGFD). Lo Lo Mai Springs is located on private property owned by Lo Lo Mai Springs Resort. Fry Springs, Turtle Springs, and unnamed springs along Spring Creek are located on private property. We estimate the proportion breakdown is approximately 60 percent AGFD and 40 percent private. We estimate a total of 10 acres (ac) (4 hectares (ha)) of habitat; 6 ac (2.4 ha) on AGFD land, and 4 ac (1.6 ha) on private land.

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BIOLOGICAL INFORMATION

Species Description

Hershler and Landye (1988, pp. 21, 23) describe the Page springsnail (*Pygulopsis morrisoni*) as a medium sized snail of the family Hydrobiidae, with a shell height of 0.07 to 0.11 inches (in) (1.8 to 2.9 millimeters (mm)). The shell is ovate or ovate-conic in shape characterized by slightly convex whorls. The inner lip of the shell is thin and usually adnate (two unlike parts are closely attached) to the body whorl. The aperture is less than half of the body whorl height and the umbilicus is open. Snails of the family Hydrobiidae are sexually dimorphic with females being characteristically larger and longer-lived than males.

Taxonomy

The Page springsnail is one of approximately 170 known species in the United States that are members of the family Hydrobiidae. The Page springsnail was originally identified by Landye (1973, p. 29) as a *Fontelicella* species. Williams et al. (1985 p. 19) recognized two species of undescribed *Fontelicella* from Tavasci Springs and Page Springs. The species was fully described by Hershler and Landye (1988, pp. 21, 23) as *Pyrgulopsis morrisoni* from a specimen collected at the type locality of Page Springs. The validity of this taxon was confirmed by Hershler (1994, pp. 52-53) and Hurt (2004, pp. 6, 8, 9, 11, 13-14). The validity has not been disputed. Thus, we have carefully reviewed the available taxonomic information to reach the conclusion that *P. morrisoni* is a valid taxon.

Historical Range/Distribution

The species was historically endemic to the upper Verde River drainage of Arizona (Williams et al. 1985, p. 19; Hershler and Landye 1988, pp. 21, 23). The historical distribution was within a number of springs located in an approximately 0.93 mile (mi) (1.5 kilometer (km)) area adjacent to Oak Creek around the community of Page Springs, and Shea Springs adjacent to Tavasci Marsh and Pecks Lake near Clarkdale. Springs within the Oak Creek Springs complex from which the species was known include Fry Springs, Lo Lo Mai Springs, Bubbling Springs, Turtle Springs, Bass House Spring, Page Springs, Cave Springs, Shea Springs, and a few unnamed springs and seeps.

Current Range/Distribution

The current range is approximately 10 ac (4 ha) in a complex of springs within an area approximately 1.0 mi (1.5 km) in length along the west side of Oak Creek and in a small area along Spring Creek, a tributary of Oak Creek (Figure 1). All extant populations are known to exist only within the Oak Creek Springs complex and in springs along Spring Creek. Springs where the species is currently known to occur include the outflow channel of Lo Lo Mai Springs, a small area along Spring Creek, Bubbling Springs Pond, Cave (Page) Springs, Ash Tree Springs, and a few unnamed springs and seeps at Page Springs and Bubbling Ponds fish hatcheries. Figure 2 depicts spring sites on the fish hatcheries. The species is believed to be extirpated from Shea Springs and Bass House Spring (but occurs in low numbers in a weir outflow near this site). Its status in Fry Springs and Turtle Springs is unknown.

Habitat/Life History

The Page springsnail occurs in springs, seeps, marshes, spring pools, outflows, and diverse lotic (flowing) waters, at approximately 3,510 feet (ft) (1070 meters (m)) elevation. The most common habitat is a rheocrene, or a spring emerging from the ground as a flowing stream. Habitats of hydrobiid snails are isolated, mid-elevational, permanently saturated, spring-fed aquatic climax communities commonly described as ciénegas (Hendrickson and Minckley 1984, pp. 133-134, 169). The substrate is typically firm and consists of cobble, gravel, woody debris, and aquatic vegetation. These substrates provide a suitable surface for grazing and egg laying (Taylor 1987, p. 5; Hershler 1998, p. 14).

Unmodified habitats exhibiting natural integrity are generally free-flowing. In modified habitats, spring vents tend to be inundated with deep water and the substrate around spring vents is typically dominated by sand and silt. *Pyrgulopsis* snails are rarely found on or in soft sediment

(Hershler 1998, p. 14). In modified habitats velocity increases in areas of outflow and sand and silt gives way to larger substrates.

Aquatic vegetation typically associated with Page springsnail habitat includes *Nasturtium officinale* (watercress), *Lemna minor* (duckweed), *Berula erecta* (water parsnip), *Hydrocotyl venicillata* (water pennywort), *Veronica anagalli aquatica* (water speedwell), and *Rumex verticillatus* (dock). Prominent aquatic macrophytes found in Bubbling Springs include *Elodea occidentalis* (waterweed), *Potamogeton gramineus* (pondweed), and *Rhizoclonium hieroglyphicum* and *Oscillaloria rubesens* (algaes). In limnocrene habitats, *Pyrgulopsis* snails can be found on or at the base of wetland vegetation (Hershler 1998, p. 14). Native aquatic invertebrates occurring within these springs include amphipods (*Crangonyx gracilis* and *Hyaella azteca*), caddiesflies (*Protoptila balmorhea* and *Metrichia volada*), other snails (*Physella virgata* and *Planorbella duiyi*), and an endemic species of leech (*Motobdella suddenness*) (Govedich et al. 1998). Dominant riparian vegetation along Oak Creek includes *Fraxinus velutina* (velvet ash), *Populus fremontii* (Fremont cottonwood), *Plantanus wrightii* (Arizona sycamore), *Salix* spp. (willow), *Prosopsis* spp. (mesquite), *Juglans major* (walnut),and *Rubus* spp. (berry bush).

The Oak Creek Springs complex is sustained by groundwater discharged from the regional artesian aquifer. Twenter and Metzger (1963, p. 29) determined that permeable sandstone beds are the primary source of water for springs in the Page Springs and Spring Creek area and much of the perennial flow in Oak Creek is from these springs. The seeps and springs in the Page Springs and Spring Creek areas supply a significant volume of water to Oak Creek. Twenter and Metzger (1963, p. 14) determined that the average base flow of Oak Creek just above the springs complex during winter months was 40 cubic feet per second (cfs), but after adding the 36 cfs inflow from springs and 16 cfs from Spring Creek, the base flow increased to 92 cfs near the mouth of the creek. The authors suggested that the actual discharge from springs was probably greater than 36 cfs, but some water was likely lost in the fish hatchery (Twenter and Metzger, p. 17). In 2006, AGFD installed a flow meter at the outflow of Bubbling Springs Pond to monitor spring discharge.

The species occurs more often and in greater densities in gravel and pebble substrates, and in water that is lower in dissolved oxygen and conductivity, and is shallower (Martinez and Thome 2006, pp. 8, 11-13). Martinez and Thome (2006, pp. 8, 14) speculated that water velocity plays an important role in maintaining springsnail habitat by influencing substrate composition and other variables.

Proximity to spring vents seems to play a key role in the distribution of hydrobiids (Hershler 1984, p. 68; 1998, p. 11; O'Brien and Blinn 1999, pp. 225, 232; Mladenka and Minshall 2001, p. 204; Martinez and Thome 2006, p. 14). Hydrobiids often exhibit dramatic declines in density downflow from spring sources, presumably due to their need for stable temperature, water chemistry, and flow regime characteristic of springheads (Hershler 1984, p. 68; 1998, p. 11). For instance, Hershler (1984, p. 68) observed decreasing abundance of Hydrobiids in outflow channels at Cuatro Cienegas, Coahuila, Mexico, and attributed the downstream decrease in springsnail numbers to changes in aquatic vegetation and algal composition and distribution. Until 2008, field investigations by AGFD and Service personnel had found that Page springsnails

were not abundant in diversion channels downstream of Bubbling Springs Pond. AGFD has since documented that springsnails are distributed along the channel about a third of a mile downstream from the pond's water flow meter. No springsnails were found at the end of the channel where the water diverts into an underground pipe leading to Bubbling Ponds Fish Hatchery (J. Sorensen, AGFD, pers. comm.). Martinez and Thome (2006, p. 14) noted that the species appeared to be more abundant near spring vents. Although Page springsnails are found in spring outflow channels, water delivery ditches, and collection ponds associated with the Oak Creek Springs complex, the species is not well established in these areas. Only those aquatic environments relatively near spring sources seem to be inhabited by significant densities of Page springsnail.

The Page springsnail is strictly aquatic and respiration occurs through internal gills. Most freshwater gastropods are herbivores or detritivores that consume algae, bacteria, and decaying organic material, or that passively ingest small invertebrates while feeding. Food is consumed by scraping from hard surfaces with a radula (tongue).

Pyrgulopsis snails are oviparous (egg-laying), though no quantitative information has been published on the reproductive biology of the Page springsnail. Raisanen (1991, p. 71) suggests Page springsnails reproduce in December and hatch in January, though anecdotal observation of size-class distribution data by Service biologists suggests the species experienced a birth pulse during the spring of 2001. Additional research is needed to clarify the reproductive biology of the species. Many prosobranch snails are annual species that reproduce several times during the breeding period (spring-fall) with varying degrees of replacement of generations. Among many prosobranchs the larval stage is completed in the egg capsule and upon hatching tiny snails crawl out into their adult habitat (Brusca and Brusca 1990, p. 759). The lifespan of the Page springsnail is unknown, but for the majority of aquatic gastropods the usual lifespan is 9 to 15 months (Pennak 1989, p. 552).

Based on our current knowledge of habitat and life history characteristics of the Page springsnail, important characteristics of its habitat appear to include: 1) permanent free-flowing springs; 2) shallow, unpolluted water; 3) coarse firm substrates such as pebble, gravel, cobble, and woody debris; 4) native aquatic macrophytes, algae, and periphyton; and 5) few or no nonnative predatory species.

Population Estimates/Status

Little information is available on population numbers of the Page springsnail. Martinez and Sorensen (2008, p. 29) found that Page springsnail populations were as high as 6,242 individuals within a rheocrene (spring emerges from the ground as a flowing stream) environment as small as 22 ft^2 (2.055 m^2) during the summer of 2001. These numbers are for a rheocrene environment and not a ponded environment. AGFD conducted a survey of Bubbling Springs Pond in November 2001, and calculated a rough population estimate of over 40,900 springsnails for that site. This estimate was based on snail densities per occupied 7.8 in (20 cm) diameter quadrats, representing a quarter of the total surface area for the pond (= 344 m^2) that is considered occupied habitat by the springsnail (AGFD 2002). Anecdotal field observations seem to suggest that Page springsnail densities are higher in rheocrene environments versus ponded

environments, but this phenomenon needs further investigation.

THREATS

A. The present or threatened destruction, modification, or curtailment of its habitat or range. The destruction, modification, and curtailment of habitat and range have had the greatest influence on the decline of the Page springsnail. At least 6 springs where the species occurs, or previously occurred, have been subject to some level of modification to meet domestic, agricultural, ranching, fish hatchery, and recreational needs. Human activity has contributed to widespread modification of the species' habitats resulting in the loss of natural springhead integrity and, in some instances, the entire elimination of the aquatic environment.

At least five springs currently or formerly occupied by the Page springsnail have been converted from rheocrene systems to ponds, which are less conducive to occupation by the species. Impoundments have inundated Lo Lo Mai Springs, Bubbling Springs, Turtle Springs, Shea Springs, and Bass House Springs. Inundated springheads are characterized by lowered flow velocity and increased sedimentation with fine substrates. The species occurs more often and in greater numbers in gravel and pebble substrates, while occurring less often and in fewer numbers in sand and silt substrates (Martinez and Thome 2006, p. 8). We anticipate that several of these springs will likely be maintained in a ponded state and this threat will continue into the future. However, the AGFD and FWS recently entered into a Candidate Conservation Agreement with Assurances (CCAA) that calls for evaluating the restoration and creation of natural springhead integrity, including springs on AGFD properties. Also, the National Park Service recently acquired the property containing Shea Springs and they have expressed an interest in restoring natural springhead integrity to that site.

Modifications at Bubbling Springs Pond occurred many years ago. Page Springs and Bubbling Springs are located on the State fish hatchery system land, are managed by AGFD, and have been utilized for fish production for decades (AGFD 1998, pp. 6-7). The management plans for the Bubbling Ponds hatchery states that one of its goals is to provide habitat for the Page springsnail (AGFD 1997a, p. 1), while the management plan for the Page Springs hatchery states that one its goals is the protection of endemic invertebrates (1997b, p. 1).

Bass House Spring had been covered with a small wooden shed since the 1950s to prevent leaves and debris from clogging the water line supplying hatchery runways. The wooden shed prevented sunlight from reaching the springhead, limiting primary productivity. AGFD removed the solid wooden shed in March 2001 and replaced it with open-air sided structure to both improve water delivery and springsnail habitat. In June of 2005, the structure was further modified from a solid surface to an open air surface. The modifications at Bass House Spring were done to stimulate primary productivity and facilitate possible future re-establishment efforts. The effect this modification had on Page springsnails is unclear. However, surveys in 2001 and 2002 did not detect Page springsnails within the springhead at Bass House Spring, but surveys did find them in a nearby drainage and springbox (AGFD 2002, pp. 4, 6). Within the modified enclosure at Bass House Spring, the aquatic environment is ponded. It is unknown

whether the habitat at this site is suitable for the Page springsnail, but recent surveys have not detected natural recolonization by the species.

The springs formerly known as Page Springs have been diverted into an underground water collection gallery for fish hatchery operations. However, Cave Springs, Ash Tree Springs, and another unnamed spring south of Cave Springs still retain limited surface flow and habitat for the Page springsnail. The Page Springs hatchery was renovated from April 1990 to October 1991 to improve fish production and meet fisheries management needs (AGFD 1988, p. 2). The renovation included the conversion of spring fields and ponds of Page Springs to an underground collection gallery. The AGFD (1988, p. 14) anticipated approximately one acre of surface water to be lost through collection pond capture and a half acre to be lost through field capture. AGFD (1991, p. 3) concluded that the renovation would reduce the area of Page springsnail habitat, and Raisanen (1991, p. 71) concluded that reductions in Page springsnail abundance resulted. Whether the Page springsnail persists in the underground collection gallery is unknown, but is unlikely because the lack of sunlight limits primary productivity and thus reduces the amount of food available to the species.

Physical and mechanical removal of emergent and submerged native or nonnative vegetation (including algae) and organic debris can modify or destroy Page springsnail habitat. Vegetation is currently removed from Bubbling Springs Pond and Bass House Spring to improve water flow to the hatchery. This activity can result in direct mortality from crushing and desiccation, and indirect mortality through habitat and water quality changes. However, the CCAA calls for landowners, including AGFD, to prevent future detrimental habitat modification that specifically reduces the threat from mechanical removal of vegetation.

Trespass livestock is a potential threat to Page springsnail habitat. In 2002 and 2003, AGFD built fences around Cave Springs, Ash Tree Springs, and springsnail-occupied unnamed springs and seeps at the Page Springs hatchery to keep cattle and humans from impacting Page springsnail habitat at these sites. In 2008, AGFD built a fence around the Bubbling Springs Pond to keep cattle and people out of this site. We are unaware of efforts to exclude trespass livestock from other springs. Habitat degradation and direct mortality could occur if trespass livestock were to gain access to the springheads. A springsnail population in New Mexico was extirpated due to the impacts of livestock grazing on their habitat (Arritt 1998, p. 10).

Ground water withdrawal is a potential concern in the foreseeable future and has been implicated in the decline of other freshwater mollusks, including other springsnails (Landye 1973, p. 1; 1981, p. 2). Ground water pumpage in the Verde Valley is minimal, probably less than 20,000 acre-feet per year (McGavock 1996, p.66). Studies reported approximately 10 years ago indicated that the groundwater system of the Verde Valley had not yet been affected by development (Koniecski and Leake 1997, p. 33) and base flow in the Verde River remained virtually identical for the periods from 1915 to 1921 and from 1965 to 1978 near Clarkdale (Owens-Joyce and Bell 1983, p. 36). However, because municipal and industrial reliance on ground water was continually growing to meet the demands of an expanding human population in the Verde Valley, future water levels and stream base flows are expected to eventually be affected (Owens-Joyce and Bell 1983, pp. 1, 65; McGavock 1996, p. 67). Blasch et al. (2006, p.

2) suggest that groundwater storage in the Verde River Watershed has already declined due to groundwater pumping and reductions in natural channel recharge resulting from streamflow diversions. If pumping of the aquifer were to substantially alter water flow toward the Oak Creek Springs complex, much of the habitat currently occupied by the Page springsnail could be adversely affected or eliminated.

Wells drilled into the aquifer supporting the Oak Creek Springs complex could be affecting spring flow. An analysis of water flow rate from Page Springs between 1996 and 2000, detected a significant decline of approximately 1 cubic foot (2.8 cubic meters) per second (Mitchell 2001, p. 1) or a 15 percent decline in flow. However, the 5-year period in which spring flow was monitored coincided with a drought period, making it difficult to tease out which factors are responsible for the decline in flow. The Palmer Drought Severity Index, published by the National Climatic Data Center, indicates severe to extreme drought conditions for 5 of the 7 years between 1994 and 2000 (Mitchell 2001, p. 5). Drought conditions and ground water pumping may play a role in recent declines in spring flow (Mitchell 2001, p. 6). Since 1997, Arizona Department of Water Resources records show that 3 wells have been drilled in close proximity and upgradient of Cave Springs. Two of these wells pump between 1200 and 1500 gallons (4.5 and 5.7 m^3) per minute, and are within 0.75 mi (1.2 km) of Cave Springs. Given their proximity, production rate, and hydrological connectivity, groundwater withdrawal by these wells could have a direct impact on flow at Cave Springs (Mitchell 2001, p. 6). However, the impact of these wells on the spring cannot be determined without long-term aquifer tests and simultaneous discharge monitoring at Cave Springs (Mitchell 2001, p. 6).

Water quality degradation through the use of toxic substances is also a current factor threatening the Page springsnail. The Page Springs and Bubbling Ponds fish hatchery facilities have undergone various chemical and physical treatments to reduce the spread of fish diseases and parasites, including defishing, dewatering, and disinfection (Landye 1981, p. 33; AGFD 1991, p. 3; 1998, p. 6). These treatments have included the use of rotenone and chlorine. Rotenone is a commonly used piscicide that acts as a respiratory inhibitor resulting in physiological suffocation, and is absorbed by bottom sediments and aquatic plants (Wiley and Wydoski 1993, p. 341). Rotenone could likely be absorbed by individual Page springsnails. Chlorine is used as a water disinfectant and is known to be toxic to fish and crustaceans (Sprague 1990, p. 506). AGFD no longer treats spring sources with chemicals, but we have no information about the use on private lands. Therefore, chemical agents may be a potential threat to the Page springsnail. However, the CCAA calls for landowners, including AGFD, to prevent future detrimental habitat modification that specifically reduces the threat from toxic substances.

Additionally, residential development had been planned for the area around Spring Creek where springs are located which provide habitat for the species. This development would likely have resulted in placement of impermeable surfaces (e.g., asphalt and concrete) near the creek, further groundwater withdrawals, and an increase in human use of the area. Specific effects are difficult to determine, but may include introduction of pollutants from urban runoff (e.g., motor oil, pesticides), increased stress on the regional water table or aquifer that supports these springs, and habitat modification from human and pet trampling. However, to our knowledge this project is currently on hold due to economic factors.

Based on our evaluation of current spring modifications, loss of springhead integrity, and the implementation of the CCAA, we conclude that stressors contributing to the present and threatened destruction, modification, or curtailment of the habitat and range of the Page springsnail are being ameliorated through the CCAA. However, we continue to find the species is threatened by regional groundwater withdrawals in the foreseeable future.

B. Overutilization for commercial, recreational, scientific, or educational purposes.
The Page springsnail is not utilized for commercial or recreational purposes. The Page springsnail has been subjected to a limited number of scientific collections to determine taxonomy, distribution, and habitat relationships. In 2001, the Service conducted a habitat study for Page springsnail within the Oak Creek Springs complex in coordination with AGFD. Over the course of this study, 2,146 live Page springsnails were collected. Although this sampling seemed to contribute to a temporary decline in Page springsnail numbers, the species was abundant the following year (Martinez and Sorensen 2007, p. 31). AGFD personnel believe collection of Page springsnail specimens has only a temporary impact on density (AGFD 2002, p. 3). Interagency monitoring no longer entails the removal of the species. Thus, overutilization for commercial, recreational, scientific, or educational purposes is not known to be a factor threatening the Page springsnail.

C. Disease or predation.
Many predators occur within these spring systems, including fish, waterfowl, and other invertebrates. Ducks and other migratory waterfowl are known to utilize Lo Lo Mai Spring pond and Bubbling Springs pond, but their impact as predators on Page springsnail is not known. However, remnants of Page springsnail shells have been found in stomach analysis of mosquitofish (*Gambusia affinis*) from the Oak Creek Springs complex (Raisanen 1991, p. 71).

Two species of nonnative snails-Chinese mystery snail (*Cipangopaludina chinensis*) and decollate snail (*Rumina decollata*)-co-occur with Page springsnails at Bubbling Springs and Page Springs hatchery. Exotic mollusks can be detrimental to native snails (Landye 1981, p. 2), however, it is unclear whether the nonnatives simply compete for resources or whether they are predators on any life-stage of the Page springsnail.

In March 2001, nonnative crayfish were noted near Bubbling Springs Pond. Crayfish are known predators of mollusks (Fernandez and Rosen 1996, p. 23). Crayfish and the other predators may negatively affect efforts to maintain extant populations of Page springsnails and future efforts to re-establish others. Due to its long-term biogeographic isolation, the Page springsnail may not be evolutionarily adapted to cope with this and other nonnative predators.

No information on disease is available for the Page springsnail, although other aquatic snails have been known to serve as the intermediate hosts for a variety of trematodes (Service 1998, p. 1).

At this time, there is not sufficient information to conclude that predation or diseases are currently a significant threat to the Page springsnail.

D. The inadequacy of existing regulatory mechanisms.
The Page springsnail is protected by Arizona Game and Fish Commission Order 42: Crustaceans and Mollusks, which establishes a closed season for the species. This rule prohibits collection and harvest, but does not protect against habitat modification. The Page springsnail is also identified as a priority species in the State Wildlife Action Plan, which helps guide AGFD and other agencies in determining what biotic resources should receive priority management consideration. No other Federal or local regulatory mechanisms provide protection for the species or its habitat.

Some protection is provided with the ownership of springs by AGFD. However, this land ownership does not provide protection from the loss of groundwater needed to ensure adequate spring flows. State law does not recognize the link between surface and ground water. Thus, surface water rights would not be sufficient to protect this springs from the effects of ground water withdrawal.

As stated above, the AGFD and the Service have entered into a CCAA to improve the conservation status of the Page springsnail (AGFD and Service 2009). In addition to protecting the species on AGFD properties, the CCAA gives AGFD the flexibility to enroll private lands through certificates of inclusion. It is our hope that this effort will soon cover the majority of the species' range.

Based on the finalization and implementation of the CCAA, we conclude that the protections from the existing regulatory mechanisms are adequate to protect habitat of the Page springsnail from direct land-based destruction or alteration. However, we continue to conclude the existing regulatory mechanisms are not adequate to protect the species and its habitats from regional groundwater withdrawals.

E. Other natural or manmade factors affecting its continued existence.
Other factors that have contributed to the decline of Page springsnail populations include the introduction of nonnative organisms, drought, and climate change.

The nonnative clam *Corbicula* spp., is also found within the Oak Creek Springs complex and may be a competitor. Nonnative ornamental pond plants have colonized springs within the Oak Creek Springs complex, which can lead to the degradation of Page springsnail habitat. However, at this time, there is not sufficient information to conclude that these nonnative organisms are currently or potentially a threat to the Page springsnail.

Periods of drought in the southwest are not uncommon. But, the frequency and duration of dry periods may be altered by climate change. Global climate change, and associated effects on regional climatic regimes, is not well understood, but the predictions for the southwest indicate less overall precipitation and longer periods of drought. Seager et al. (2007, p. 1181) predict, based on broad consensus among 19 climate models, that the southwest will dry in the 21st century and that the transition to this drier state is already underway. The increased aridity associated with the current ongoing drought, and the 1950s drought, will become the norm for

the southwest within a timeframe of years to decades, if the models are correct. Certainly this species, along with its habitat, will be affected in some manner by climate change; but the magnitude and extent of the change cannot be quantified at this time.

Therefore, based on our evaluation, we conclude that the Page springsnail is threatened by other natural or manmade factors affecting its continued existence in the foreseeable future.

CONSERVATION MEASURES PLANNED OR IMPLEMENTED

The Page springsnail is identified as a priority species in the State Wildlife Action Plan. This plan helps guide AGFD and other agencies in determining what biotic resources should receive priority management consideration.

Seasonal monitoring surveys within the Oak Creek Springs complex began in 2001 by the Service and AGFD. The monitoring protocol was revised in 2002, and AGFD had three staff biologists working on Page springsnail conservation and monitoring. Initial funding for AGFD to manage the species was provided from State and Federal grants. AGFD has secured a State Wildlife Grant for the conservation and management of mollusks of greatest conservation need in Arizona, which includes the Page springsnail.

More importantly, on October 8, 2009, the Service and AGFD entered into a CCAA for the Page springsnail that is aimed at improving the conservation status of the species and its habitats. We anticipate that implementation of the CCAA will greatly improve the status of the species.

Management plans for the Bubbling Springs and Page Springs fish hatcheries include provisions to protect endemic invertebrates and provide habitat for the Page springsnail. The Environmental Assessment for the Page Springs Hatchery Renovation included commitments to replace lost habitat and to monitor remaining populations. However, efforts to replace lost habitat have not yet been successful. For instance, in 1992, a Boy Scout troop conducted a Page springsnail habitat rehabilitation project at the Page Springs Hatchery. This project entailed the construction of ditches approximately 50 yd long, 18-24 in wide, and 12 to 18 in deep from Ash Tree Spring. These ditches were then lined with river rock to provide firm substrates for occupation by Page springsnails. However, field investigation by the Service and AGFD personnel in 1998 revealed that the restored spring run was largely dry and lacking aquatic habitat suitable to support the species. In 2001, a small portion of that area contained flowing water. Annual surveys since 2001 have indicated the species continues to occupy the springhead at Ash Tree Spring.

Conservation measures identified in the CCAA include: 1) Prevent future detrimental habitat modification at known localities; 2) Identify and obtain funding to study the ecology and distribution; 3) Develop both Page springsnail and hydrologic monitoring programs; 4) Evaluate and safeguard the aquifer supporting Page springsnail habitat; 5) Evaluate and restore springheads to historical condition; 6) Identify source population(s) for re-establishment efforts; and 7) Translocate Page springsnails to suitable habitats.

Conservation measures that AGFD and the Service have already completed principally involve information collection and include: 1) Fencing installed around springheads at the Page Springs Hatchery and Bubbling Springs Pond; 2) Page springsnail monitoring protocol drafted; 3) monitoring of Page springnsnails at Page Springs and Bubbling Springs hatcheries; 4) Water flow measuring station installed at Bubbling Springs pond; 5) Interim monitoring report prepared by AGFD (2002); 6) Habitat usage study published by the Service; and 7) Experimental spring run created. However, additional monitoring is needed to assess the overall effectiveness of these measures in reducing or removing threats.

SUMMARY OF THREATS

At least six springs where the Page springsnail occurs have been subjected to habitat destruction, modification, or curtailment to meet domestic, agricultural, ranching, fish hatchery, and recreational needs. Nonnative species, removal of aquatic vegetation, and application of chemicals have all contributed to degradation of habitat and decline of the species. However, although these threats continue to be imminent, we believe they will be significantly alleviated through the implementation of the recently finalized CCAA. Additionally, ground water withdrawal is expected to become a threat in the forseeable future. Accordingly, we find that this species is threatened throughout all of its range, and, therefore, find that it is unnecessary to analyze whether it is threatened in a significant portion of its range.

For species that are being removed from candidate status:

____Is the removal based in whole or in part on one or more individual conservation efforts that you determined met the standards in the Policy for Evaluation of Conservation Efforts When Making Listing Decisions (PECE)?

RECOMMENDED CONSERVATION MEASURES

Continue working with the State and other landowners to refine and implement conservation efforts through the CCAA in order to alleviate the threats to the species and its habitat.

LISTING PRIORITY

THREAT			
Magnitude	Immediacy	Taxonomy	Priority
High	Imminent	Monotypic genus	1
		Species	2
		Subspecies/population	3
	Non-imminent	Monotypic genus	4
		Species	5
		Subspecies/population	6
Moderate to Low	**Imminent**	Monotypic genus	7
		Species	8*

	Non-imminent	Subspecies/population Monotypic genus Species Subspecies/population	9 10 11 12

Rationale for listing priority number:

Magnitude: All of the springs in which the species is found have been modified or subjected to adverse management action. While habitats will continue to be maintained in their modified form, and management actions that could result in habitat degradation and direct mortality of Page springsnails will remain imminent, we believe the magnitude of threats will be ameliorated through implementation of the CCAA. The entire range of this species has been affected by habitat modification and loss of springhead integrity, resulting in a biologically significant reduction in the rangewide abundance and distribution of the Page springsnail. However, as part of the CCAA, conservation measures will be implemented to restore habitat, increase population levels, and expand the species range. Although the potential detrimental effects from groundwater depletion could result in complete drying of these spring systems and extinction of the species, cooperators under the CCAA will seek management solutions to address this threat. Conservation measures are currently being implemented under the CCAA, and time is needed to evaluate if these efforts can effectively remove the major threats facing the Page springsnail. Therefore, the magnitude of threats is moderate.

Imminence: Several of the major threats facing this species, such as the maintenance of springs in unnatural ponded conditions, the mechanical removal of aquatic vegetation, and the persistence of nonnative predatory organisms, are currently occurring, and are therefore, imminent. There is conflicting information regarding the certainty of the threat of groundwater withdrawal. Outdated comprehensive studies show that the groundwater in the Verde Valley was not been affected by development. However, focused investigations on the fish hatchery show otherwise. Although we believe that the CCAA will reduce threats, we still conclude that based on ongoing activities related to domestic water use, fish hatchery operations, agriculture, and nonnative species, that the overall threats to this species are imminent.

Rationale for Change in Listing Priority Number: The implementation of the CCAA has already reduced several threats and will continue to contribute to an improvement in the conservation status of the species. Accordingly, we are changing the LPN from 2 to 8.

_X_ Have you promptly reviewed all of the information received regarding the species for the purpose of determining whether emergency listing is needed? Yes

Is Emergency Listing Warranted? No. We are currently working with AGFD to implement a CCAA. Specific conservation measures have been identified, and some have been implemented. Because conservation efforts are ongoing, we believe emergency listing is not warranted.

DESCRIPTION OF MONITORING

Monitoring has been ongoing since 2001 by AGFD and Service personnel. At a minimum, this

monitoring entails visual inspection of springs to ensure that the species is persisting. When possible, monitoring entails quantitative measurements of abundance and habitat. Since the last candidate review, monitoring has not shown any change in the status of the species. As part of the CCAA, the Service and AGFD have cooperatively developed a detailed monitoring program. This effort is being implemented. The results of initial monitoring are presented in AGFD (2002) and Martinez and Thome (2006). These studies have mostly provided information regarding habitat use and characteristics.

COORDINATION WITH STATES

Indicate which State(s) (within the range of the species) provided information or comments on the species or latest species assessment: Arizona Game and Fish Department personnel reviewed and commented on this assessment.

Indicate which State(s) did not provide any information or comments: n/a

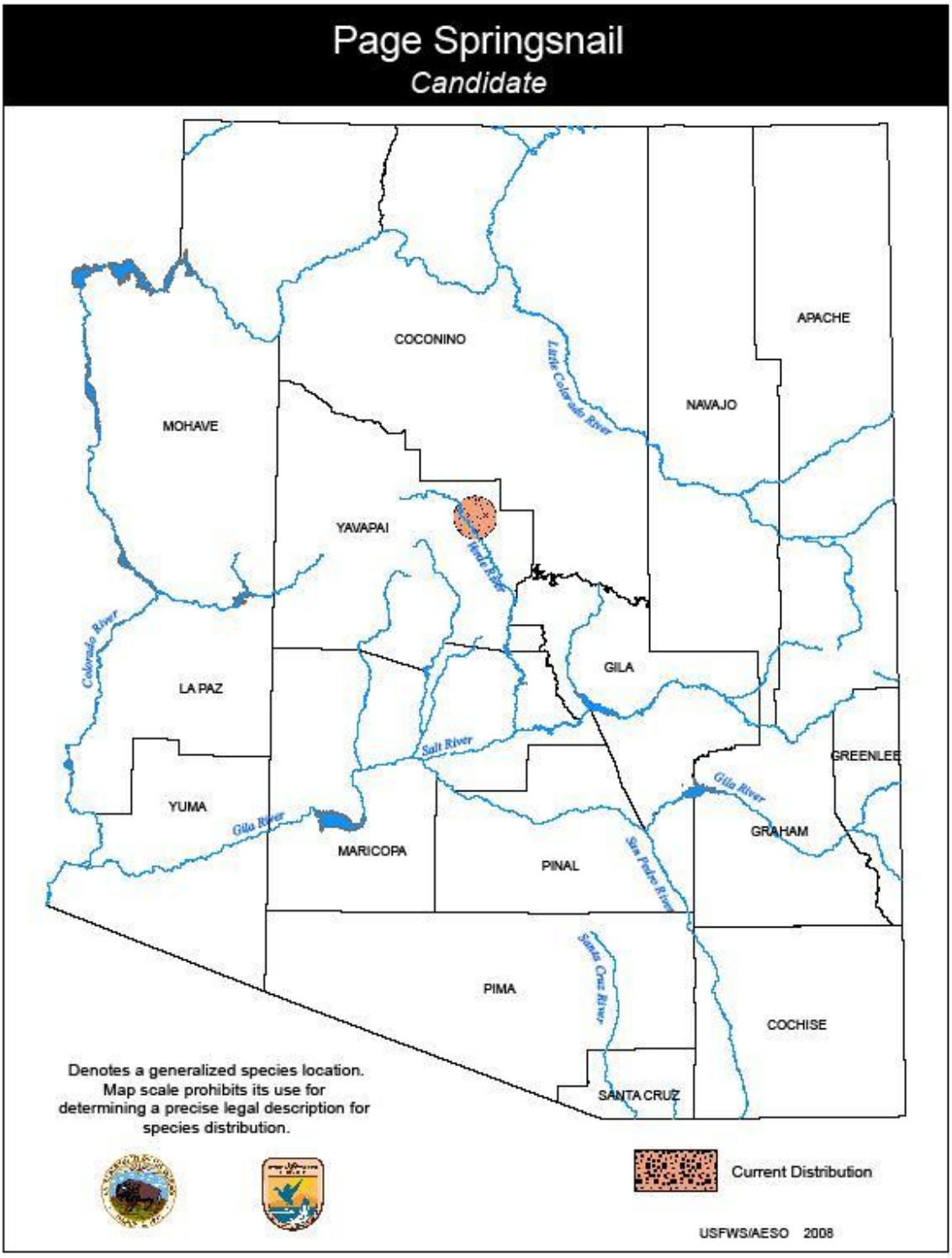

Figure 1. Distribution of Page springsnail.

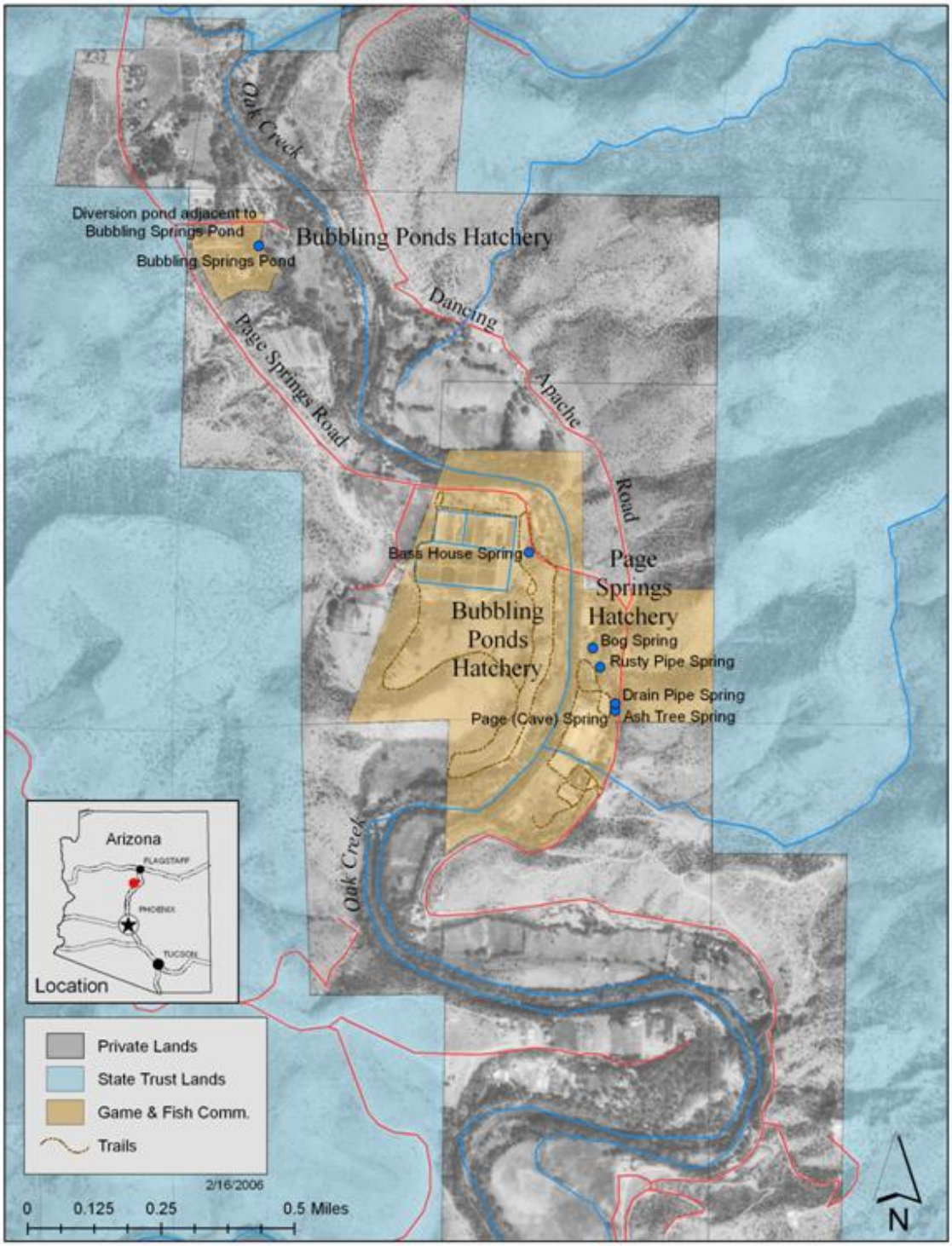

Figure 2. Springs on Arizona Game and Fish Department fish hatcheries.

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APPROVAL/CONCURRENCE: Lead Regions must obtain written concurrence from all other Regions within the range of the species before recommending changes, including elevations or removals from candidate status and listing priority changes; the Regional Director must approve all such recommendations. The Director must concur on all resubmitted 12-month petition findings, additions or removal of species from candidate status, and listing priority changes.

Approve: _____ May 21, 2010

Acting Regional Director, Fish and Wildlife Service Date

Concur: _____ Date: October 22, 2010

ACTING

Director, Fish and Wildlife Service

Do not concur: _____ _____

Director, Fish and Wildlife Service Date

Director's Remarks:

Date of annual review: April 2010
Conducted by: Michael Martinez